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OF

CEREAL CHEMISTS

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TO THE MEMBERS

It seems to me that a few words concerning ourselves would be in order at this time. Flour mill chemists are not generally overworked at this time of the year and I would sound a word of warning and speak a word of encouragement regarding the work of the association.

We have a responsibility on our shoulders which, I fear, at times rests all too lightly on us. It has been nearly seven years now since the A. A. C. C. was organized; many of the problems that existed then to stimulate our endeavor are still to be met and solved. Much has been accomplished, it is true, but the field certainly offers inducement for further effort. We have always received encouragement from mill owners and managers and if, for no other reason, it would seem that active efforts should be made to make very evident progress along the line which prompted our existence.

One handicap that we have worked under has been many duties and insufficient help to make research work possible. That is a consideration that cannot to be avoided in industrial laboratories but it offers no excuse for failure to take advantage of slack seasons or periods of non-operation. The following resolution by the executive committee of the Association of Operative Millers was passed at a recent meeting. I wish to call it to your attention for thoughtful consideration:

"Whereas, Present laboratory results are variable, owing to a want of standard methods of determination, and

"Whereas, Such results are largely dependent on age and condition of the flour, and the character of the wheat from which it is made; therefore,

"Resolved, That the Association of Operative Millers recommend to all operative and operating millers to discourage orders based on such unreasonable guarantees."

Thus we see our efforts as others see them. Certainly it should stimulate each of us more active endeavor. Our association thru its officers in undertaking to work with the operative millers association for the mutual benefit of each. I believe it is a very wise step on our part and I feel sure it will result in much good. We must strive hard to measure up to the expectations of the industry and I call on each one of you to do some serious work along the lines suggested at our last meeting. It is not long now till our next general meeting but there is ample time to do a considerable amount of good work.

A problem that has been avoided by our members because of the wide diversity of opinion is that of a standard formula. It seems that if we would each one make a serious effeort to bake better bread with the proposed formula and keep our minds free from prejudice that we could safely and profitably consider the subject at the spring meeting.

I would emphasize the need of an impartial mind and a desire to prove that such a problem is possible of solution. Most certainly our members are intelligent enough to be able to see what a great stride ahead such a thing as a standard or basic baking formula would be. I hope that we may be able to, at

least, make progress along this particular line at the coming meeting. Work along this line could be carried out in conjunction with our routine work and simultaneous with research in other directions.

Our membership is constantly growing which is certainly a good omen and the interest of the mill owners is with us which is much appreciated. We must consider seriously our responsibility to the association, the millers and ourselves. There is an enormous amount of business of a permanent nature carried on in this country in cereal products. Our pride should demand that we achieve something each year toward clarifying conditions of inspection and analysis; our ambition should stimulate us to endeavor. These things being true, let me urge on each one to apply himself to the problems before us.

PRESIDENT.

THE CHEMIST AND THE SALES DEPARTMENT

The duties of a chemist are so many and varied that when an attempt is made to clearly define them, we find ourselves floundering in each department of business. When crystallized this simply means there is a vast field in which a chemist can work to good advantage for his company. His prime purpose is of course the product he is helping to manufacture, but under this heading must be included: the things which go into this product, the standards of quality that must be maintained, etc.

Just what is his relation to the sales department?

To the average salesman first patent, second patent or clear means a proportional number of dollars per barrel, F. O. B., Jungletown, in jutes, cotton or clay fill. To the chemist the same flours have a far different meaning. The fact that the two are versed along different lines, yet workingfor the same object makes it imperative that they do team work. There are various lines along which the two can accomplish better results through team work than by individual effort. The salesman receives an inquiry from the Sour Dough Bread Co. or the Shovel-em-maki Spagetti Co. They are willing to pay just so much and the flour must suit their need. The salesman knows what grades can be offered for the price, the chemist knows the characteristics of all the different-grades and together they will be able to consumate the deal or at least avoid writing a contract it is impossible to fill.

It is difficult to trick the average salesman yet instances have been known in which over eager salesmen have made contracts under specifications of quality which they were unable to produce. Net results: Loss. Had the chemist been consulted he could have easily detected and pointed out the "joker" thereby avoiding loss, or at least, been in the position to say, "I told you so."

In the matter of kicks on products and adjustments for the same, the salesman and the chemist working together are more likely to arrive at a just understanding with the trade than when the attempt is made single-handed. There is an over-worked slogan which reads, "The trade is always right." The recent decline in the market has caused many to turn this motto—face to the wall. Lower prices and kicks rode (or at least started) on the same toboggan. The arrival of the former saw the advent of the latter. To the chemist fell the task of judging the justified from the unjustified. The salesman armed (through the chemist) with the absolute knowledge of the condition of the product, was in a position to talk "turkey" and make or not make adjustments which ever way the facts warranted. In many instances where the trade is having trouble using the flour if complete and honest data is furnished to the chemist he is able to straighten them out. When declining prices is the prime motive for the kick all analyses and recommendations fail.

Briefly speaking the chemist stands as the one best informed on the various grades of flour, how and where they may best be employed and in his daily routine as a recorder of facts stands as an impartial judge of quality and service between his company and their trade.

M. C. MANN.

RAPID VOLUMETRIC DETERMINATION OF REDUCING SUGARS IN CEREAL PRODUCTS

The importance of the determination of reducing sugars as an indication of the grade, quality and baking value of a flour and the milling value of wheat can hardly be overestimated. It has been shown by Weaver (1) that the increase of reducing sugars, acidity and soluble proteins lead to inferior results in baking. His work also shows that an accurate indication of the condition of wheat may be obtained by these determinations. Further than these it can hardly be disputed but that an increase in water soluble solids indicate a condition that tends to decrease the quality and baking value of flour.

For the determination of acidity, soluble proteins, and soluble solids, methods have been worked out that are quite applicable to the routine work of a cereal laboratory. The value of these methods is determined by their accuracy, brevity, and elimination of tedious procedure. So far no rapid method for determining reducing sugars has proven satisfactory as a routine feature of cereal laboratories. Especially is this true of the of the volumetric methods and the cereal chemist has had to fall back upon the standard gravimetric method by the use of Fehling's solutions for the determination of reducing sugars.

Hess (2) has worked out a line of procedure for the volumetric determination of sugars by combining the gravimetric method by use of Fehling's solutions and Kendall's volumetric method for the determination of copper. However, this method is open to criticism on account of the great number of solutions employed and the tediousness of procedure. Also he has stated that there is much danger of oxidation of the cuprous oxide if close attention is not paid to the various steps. One of the most objectionable features of his method is the removal of nitrous acid formed, by using sodium hypochlorite thus making it necessary to remove the chlorine formed by means of phenol.

Hess states that bacterial action is inhibited by addition of a few drops of toluene water. In the method of extraction as employed in this work a few preliminary analyses proved that neither toluene nor liquid petrolatum had any effect upon the final results. Weaver has stated that good comparable results can be obtained at any constant temperature and time but suggests a two hour extraction at 10 degrees Centigrade as giving nearer the absolute amount of sugars present. Several two hour extractions were made at 10 degrees and 40 degrees and the differences in results were, in all cases, less than 2 per cent and in the majority of trials the difference was less than the toleration for experimental error. Thus it was assumed that a two hour extraction at 40 degrees Centigrade gave a neglible amount of diastatic action though Weaver has stated that a four hour extraction at 40 degrees centigrade would give a good idea of diastatic action.

The polariscope has become quite important as a means of determining sugars but the majority of industries maintaining cereal laboratories do not care to go to the expense of procuring a polariscope for just the determination of sugars. Many mills are slow to become aggressive in the matter of scientific research and some even refuse to follow where it has been definitely shown that scientific methods can work great improvement in their products.

The use of Fehling's solutions in the determination of reducing sugars has only one point, its great accuracy, to recommend it as a routine method. The determination is quite long, very tedious and requires constant attention. Then a very careful manipulation is necessary to avoid oxidation of the cuprous oxide.

This work has been undertaken to test the applicability of the modified cuprous chloride-iodine method for reducing sugars, as described by Scales (3), which is quoted.

"When the Benedict's solution containing the sugar has been boiled and the cuprous oxide has been precipitated, the solution may be acidified with a dilute acetic acid which does not attack the cuprous oxide, a known excess of iodine may be added, and the cuprous oxide then dissolved by the addition of a very small quantity of hydrochloric acid. The cuprous chloride formed is immediately acted on by the iodine with the formation of cuprous iodide and finally cupric iodide. The presence of the cuprous iodide is not evident in this method as it is in the others, for the solution never has any cloudiness or precipitate As soon as the cuprous oxide is all dissolved by the hydrochloric acid the excess of iodine is titrated with the thiosulphate, starch solution being used

as the indicator. The difference between the thiosulphate value of the iodine added in a determination and the thiosulphate required to reduce the iodine after the formation of cupric iodide is equivalent to the amount of of reducing sugar present. The value of the iodine in cc. of thiosuplhate must be determined by titration in distilled water and not in the presence of the reagents employed in the determination. In a test with all the reagents, but no sugar present, 0.3 or 0.4 cc. of iodine is reduced hydrochloric acid and so the results are low by this amount, but in a regular determination all this iqdine unites with the copper so that the full iodine value is obtained.

This method for sugar determination may be carried out in one flask without the thistle tube and pipettes which Clark's method requires. It does not necessitate the precautions against oxidation by the air nor the care that he had to exercise in measuring the iodine from a pipette since the iodine may be rapidly run into the solution from a burette without great care concerning the exact quantity, although the amount used must be carefully read at the end of the titration with thiosulphate before making any calculations.

Reagents.—The Benedict's solution employed is the one recommended by Clark.

Copper sulphate crystals_____ 16.0 g.
Sodium citrate _____150.0 g.
Sodium carbonate, anhydrous____130.0 g.
Sodium bicarbonate _____ 10.0 g.
Water to make a final volume of 1 liter.

The copper may be dissolved separately in 125 to 150 cc. of water; the remaining solid constituents in about 650 cc. of water; heating to accelerate solution. When all are in solution pour the copper solution slowly into the other with stirring, make up nearly to volume, cool, complete the volume to one liter and filter. None of the weighings or measurements need be made with extreme accuracy. In addition to this the method requires an approximately 0.04 N iodine solution; a thiosulphate solution made approximately 0.04 N; hydrochloric acid solution diluted so that every 25 cc. contains 1.5 cc. of the concentrated acid (1.19 sp. gr.); an acetic acid solution containing 2.4 cc. of the glacial acid in every 100 cc.; and a starch solution made in the usual way with either potato or soluble starch. A pure dextrose solution should be employed to standardize the apparatus and thiosulphate solution. A pure dextrose for this purpose may be obtained from the Bureau of Standards. The thiosulphate solution is made by dissolving 10 grams of the pure salt in one liter of water. Its sugar equivalent should be determined by making some regular sugar determinations with pure dextrose but may be standardized against N/20 potassium bichromate.

Apparatus—The solutions were boiled in a 300 cc. Erlenmeyer flask with a 2-hole rubber stopper. A smaller flask will serve as well. In addition to this there is required a 100 cc. cyinder or any container for approximately this quantity, a 25 cc. pipette and two burettes, or, if one prefers to deliver the iodine from a pipette, a 10 cc. and a 25 cc. pipette may be substituted for one of the burettes. If pipettes are used, one of 5 cc. will be convenient where the reduction to cuprous oxide is so slight that the solution shows practically no clouding or precipitate; the 10 cc pipette may be employed where very small quantities of the oxide settle to the bottom of the flask; and the larger pipette for all larger quantities of the precipitate.

Procedure—The procedure for making a determination consists in pouring 20 cc. of the modified Benedict's solution into a 300 cc. Erlenmeyer flask and then making the volume up to 30 cc. with the sugar solution and distilled water if necessary. If there are present more than 20 mgs. of dextrose better results may be obtained by using 25 cc. of Benedict's solution and making the volume up to 35 cc. with the sugar solution. The flask is then placed over a flame or on a hot plate. When using the electric hot plate to heat the solution, the flask should be closed with a 2-hole rubber stopper in order to bring the solution to the boiling point quickly. The hot plate employed in this work, required about five minutes to bring the solution to boiling. When the total volume was 35 cc it required one and three-quarter minutes longer to boil. As Clark has shown in his work, when a burner is used to heat the solution it should be adjusted so that the total time of heating will be only about one minute less than that allowed for the plate. The period of heating and the intensity of the heat must be constant for all determinations. The boiling was continued for three minutes. The solution was then cooled as quickly as possible, usually in a minute, by holding the flask under the cold water faucet and rotating it. When cold, the 100 cc. of dilute acetic acid may be poured into the solution and the

iodine immediately run in from a burette. The dilute hydrochloric acid is then run in from a 25 cc. pipette which is held against the side of the flask up near the neck, so that the acid will spread over the side of the flask as it runs down; the solution is vigorously rotated to produce an immediate distribution of the acid and thus prevent any concentration of it that might act on the iodine. The pipette and the side of the flask are washed down with a few cc. of water and the solution rotated for exactly one minute. Any precipitate should be entirely dissolved in this time. The thiosulphate solution is now carefully run into the flask till its brown or blue solution changes to a light sea green, when 2 cc of starch solution may be added and the titration continued until the dark iodo-starch blue suddenly fades away and the solution remains the light blue, characteristic of acidified copper solutions. The end point is permanent."

The method has been tested on 37 samples covering the general work of a cereal laboratory. All samples were run in duplicate for each method and averages have been given. Where results were of such wide variance that it was patent a mistake had been made in manipulation the results were not recorded.

The extractions were made by the A. A. C. C. method for acidity. This method of extraction was used as it was desired to check the method on a solution easily obtained on which other determinations could be made thereby reducing to a minimum the number of extractions for a maximum of work. This method in brief is as follows: 10 grams of flour are treated with 250 cc. of distilled water free from carbon dioxide, digested for two hours at 40 degrees Centigrade, centrifugalized for ten minutes, and filtered. A 10 cc. aliquoit, representing 0.4 gram sample, was used in both the Fehling's and Scales' methods.

The determinations by the gravimetric method and using Fehling's solutions were made by the Official Munson & Walker General Method of the A. O. A. C., page 78, paragraph 25, Methods of Analysis, A. O. A. C. Alundum crucibles of minimum porosity were used in place of Gooch crucibles and asbestos. In no case was there loss of copper due to filtering through crucibles used Tables used in interpolating cuprous oxide results were the Official Munson & Walker tables of the A. O. A. C.

In the preparation of solutions as recomended by Scales the weighings were made approximately but solutions were carefully standardized. In the case of the dextrose a very pure sample was obtained and this solution made up very carefully and standardized by three different methods.

When standardizing the thiosulphate and iodine solutions they are not standardized as to normality but in terms of each other. To standardize these solutions they are titrated in distilled water and in this work were titrated both ways. From these results the thiosulphate equivalent of the iodine is obtained and used thus in calculating determinations. Then a regular determination is made using the standard dextrose solution and the dextrose value of the thiosulphate per cc. computed.

The following table shows the comparison between the two methods. All results are expressed in milligrams dextrose and represent the amount present in one gram of sample.

Date run	Sample	Fe'ing	Scl's	Differ.
11- 4-20	PW-1	19.01	19.27	+0.26
11- 5-20	L.P.	15.10	15.33	+0.23
11- 5-20	PW-2	17 04	17.18	+0.14
11- 6-20	PM-1	21.00	20.91	—0.09
11- 7-20	PM-2	20.80	20 91	+0.11
11- 9-20	PM3	21.02	20.91	—0.11
11- 9-20	BPW	11.14	11.50	+0.36
11-11-20	PM-4	17.15	17.78	+0.63
11-12-20	PM-5	18 00	19.96	+1.96
11-13-20	PW-3	18.90	18.47	—0.43
11-16-20	DW-1	15.25	15.38	+0.13
11-16-20	SBr.	48.92	49.04	+0.12
11-17-20	PS-1	17 95	18.47	+0.52
11-17-20	Ix	18.05	18.50	+0.43
11-17-20	PW-4	15.60	16.09	+0.49
11-17-20	PW-5	15.85	16.09	+0.24
11-18-20	DW-2	17.80	17.08	—0.72
11-18-20	GC-1	19 10	20.22	+1.12
11-18-20	PS-2	17.60	17.43	—0.17
11-18-20	PM-6	24.90	25.09	+0.19
11-18-20	PSIS	666.90	667.50	+0.60
11-18-20	PSSS	60 40	60.70	+0.30
11-18-20	IxIS	639.80	640.00	+0.20
11-18-20	IxSS	62.70	62.80	+0.10
11-19-20	DW-3	15.35	15.52	+0.17
11-19-20	GC-2	21.00	21.20	+0.20
11-20-20	DW-4	15 00	15.05	+0.05
11-20-20	GC-3	20.26	20.20	—0.06
11-22-20	PW-6	17.76	17.93	+0.17
11-23-20	DW-5	15.95	16.02	+0.07
11-23-20	GC-4	22.01	22.04	+0.03
11-23-20	PS-3	17.62	17.85	+0.23
11-23-20	PW-7	17.99	18.01	+0.02
11-26-20	DW-6	15.18	15.21	+0.03
11-26-20	FP	16.06	16.11	+0.05
11-26-20	PS-4	18.07	18.33	+0.26
11-26-20	Ba	24 33	24.30	—0.03

This work was done on regular daily samples on which the sugar percentage

was wanted. Some explanation of the sample markings would be of interest. PW=a patent rye flour; PM= a medium or short straight rye flour; BPW is also a patent rye flour; DW=a short patent wheat flour; GC=a straight or baker's patent wheat flour; FP=a long patent wheat flour; PS=a first clear wheat flour; Ix=a second clear wheat flour; Ba=a combined wheat clear flour; SBr=stale bread; PSSS and IxSS=soluble starch (inverted) of the grades PS and Ix; PSIS and IxIS=insoluble starch (inverted of the grades PS and Ix.

Comparison of results show that but little variation is obtained between the two methods. This error when expressed in terms of percentage is practically negligible. In the majority of cases the results by the volumetric method are slightly higher than those of the gravimetric method. In all of the work done the operations were carefully standardized. The averages only being given, do do not show the comparison between duplicates but in nearly every case the duplicates for the volumetric method were closer than those of the gravimetric method.

The solutions used in this work were prepared about two months before being used and were standardized just before experiments were started. The solutions were then checked every three days during the three weeks the analyses were being carried on but no change was found in them. The thiosulphate solution was kept in a brown glass bottle wrapped in paper to exclude all light possible. By carefully sterilizing the starch solution and the flask in which it was kept, and then adding a few cc. of liquid petrolatum to the starch solution, it was kept for several months in good condition. A Bunsen burner was used in heating all solutions by both methods, flame being carefully regulated and then all samples heated on the same flame.

As an idea of the time value of this method it was found that, after extraction and centrifugalization, an operator working alone could run with ease one determination every ten minutes, making twenty minutes for each sample in duplicate.

The exact procedure, in brief, as carried out in this work, is as follows: Extract 10 grams sample in 250 cc. distilled water, free from carbon dioxide, for two hours, decant into centrifuge tubes, centrifugalize for ten minutes, pipette 10 cc. aliquoits into 250 cc. Erlenmeryer flasks, add 20 cc. modified Benedicht's solution, add 5 cc. distilled water, place on burner and bring to boil in four minutes, boil three mintes, remove from flame and rotate flask under stream of cold water for one minute, add 100 cc. acetic acid solution, add 10 cc. iodine solution and do not shake, add 25 cc HCl solution down side of flask, agitate thoroughly, wash down sides of flask and rotate flask for one minute, run in thiosulphate solution until dark brown or blue solution turns to sea green, add 2 cc. starch solution and carefully titrate with thiosulphate solution until starch-iodo color suddenly fades to light blue of acidified copper solutions.

Calculations are easily made as follows: From the thiosulphate equivalent of iodine used, subtract the amount thiosulphate used in titrating excess iodine and multiply this result by the dextrose value of the thiosulphate. This will give milligrams dextrose in aliquoit representing 0.4 gram sample when above extraction concentration is used. To determine milligrams in one gram sample multiply by 2.5 or divide by 0.4 and result will be in milligrams dextrose per gram sample used.

When agitating sample after addition of hydrochloric acid, foaming sometimes occurs but this is because sample has not been sufficiently cooled. After agitation if sample is light blue instead of dark brown or blue it indicates that sufficient iodine has not been added. More iodine may be added at this point, solution agitated one minute and determination carried forward. However, it is recommended that the determination be repeated using sufficient iodine at first addition of this sample. On a few the sample run a one minute agitation period was found to be insufficient to dissolve all of the cuprous oxide and in these cases the sample was agitated slightly longer until all of the cuprous oxide had apparently been dissolved.

The use of the same amount of iodine solution for all determinations is advocated as it greatly simplifies calculations by giving one a constant thiosulphate equivalent. Where extraction concentration is made as stated and a 10 cc. aliquoit used, 10 cc. of iodine solution is sufficient for most of the work of a cereal laboratory

CONCLUSIONS: The method as suggested by Scales for the determination of reducing sugars has been tested as to its applicability to the routine work of a cereal laboratory.

Its accuracy in comparison with the gravimetric method employing Fehling's solutions has been well established.

As an accurate, rapid, volumetric method for the special or routine determinations of sugars in cereal products it has proven to be of more value than any method heretofore proposed.

On account of its brevity and lack of tedious procedure it is the most efficient method that can be used in cereal routine work.

The use of this method is recommended for cereal laboratories.

REFERENCES.

(1) Journal A. A. C. C., Vol. III, No. 1, December, 1918.

(2) Journal A. A. C. C., Vol. V, No. 1, August, 1920.

(3) Journal of I. & E. Chemistry, August, 1919.

SAMUEL J. LAWELLIN.

RELATION OF GRADE, CLASS, AND ORIGINATING POINT OF WHEAT TO VOLUME OF BREAD BAKED FROM FLOUR MADE THEREFROM

It has often been asked as to which grade of wheat gave the most strength to the flour made from it, and what are the reasons for this variation. There are so many conditions entering into this feature that it would be hard to name any specific condition that entirely causes the differences noted in wheats and flours. There is no question but that the climatic conditions enter very largely into the strength of wheat and that perhaps no two crops from the same locality will show the same strength. Also, it has been proven that soil conditions have much to do with the strength of the wheat and also to its yield. There are many other direct or indirect reasons, such as excessive amounts of soluble protein, water soluble solids, acidity, and reducing sugars. Also the percentage of ash and the ratio of mineral water contained in the ash correspond to marked differences in the strength of flour made from various wheats.

For many years it was thought that nothing but soft wheat could be raised in Colorado on account of the climatic conditions. It was also noted that when wheat of the hardest types was raised for a number of consecutive years in Colorado that it would in time turn to soft wheat. This prompted the Colorado Experiment Station to investigate the cause and see if the soft wheat conditions were not remedial. This was of vast importance to the farmers of the state as their wheat was selling at a much lower price on the market and millers were loathe to accept it even at reduced prices on account of the soft state of the wheat which greatly lowered its milling value. At first the reason assigned to this condition of the Colorado wheat was that it was irrigated wheat. Then when it was noted that even the wheat from the dry farming area of Colorado was of this same nature it was readily accepted that the climatic conditions was the chief cause of the softness of wheat from this section. Reporting its findings in Bulletin No. 247, "A Study of Colorado Wheat," the Experiment Station has definiely shown that it was neither the result of irrigation or climate that caused wheats grown in this part of the wheat belt to tend to be soft. They have advanced the theory that it was soil conditions and then have gone ahead and proven this to be the case. By adding to the soil the mineral elements that were lacking they have continuously grown for a number of years the hard strains of wheat. These wheats were grown under both the dry farming and irrigation methods and have not turned to the soft varieties.

Climate has much to do with the nature and strength of wheat, however, as proven by the different varieties of wheat best suited to the various sections of the country. Quite different strains of wheat are grown in the Pacific Coast Area, the Great Plains, and the Eastern part of the United States. These strains are those best suited to the climate and soils of the various localities in which they are grown. A few years ago an interesting experiment was carried out by the Experiment Stations of the States of California, Maryland and Kansas, whereby exchanges were not only made with regard to strains of wheat but the actual soil of each of the three stations. The wheat of each station was grown at each of the three stations in the soil of each of the stations. The results are quite interesting as explaining climatic and soil conditions.

The condition of the growing and ripening season has a large amount of influence on the strength of wheats. This was very pronounced during the crop year of 1915, which was a very wet season and about the poorest crop of wheat, from

milling standards, that has been produced, was gathered that year. Too much moisture during the ripening season is one of the worst things that can happen to a crop of wheat. There needs must be some rainfall during the blooming season to get good distribution of pollen and insure a well filled head. And there must also be sufficient moisture in the ground so that the wheat will not suffer. But plenty of sunshine is essential during the ripening season.

Not being able to get accurate information on the growing season of the various wheats the miller must fall back upon chemical analyses to get the desired information as to the real condition of the wheat which he has to grind. By analyses, of the soluble proteins, soluble solids, reducing sugars, ash, total proteins, and acidity, the miller who knows his wheat can tell which wheat is the best for the particular flour which he wishes to make and also buy on the market so that he can get to good price advantage the wheats that will make the blend that he desires. Too many millers buy the wheat that is on the market and look only at the price without taking into consideration the qualities of the wheat except as to federal grades. And federal grades are about the most misleading things that one can tack onto a sample of wheat. The only two things that the federal grade tells the miller is which sample has the most pounds per Winchester bushel and from which one he can get the largest yield of flour and even then sometimes the latter is misleading. A fine looking wheat may be the weakest one of the lot and the most expensive to the miller tho he may buy it at a price that coupled with the yield will bring him more returns at first than some of the other grades fo wheat. And then it is almost beyond the question of a doubt that No. 1 wheat is not the best wheat in all classes.

The baking test is the one final test that shows plainly the strength of wheat. The miller that lets the commercial baker make this test for him after the flour has been made and sold will find lots of trouble in his lot with the advent of the various crop years. There is no doubt but that the best wheat as to grade will shift from year to year the same as the quality and yield will shift for each of the grades. It might be of interest to compare a few classes and grades of wheat as to what the baking test alone has shown. The strength of the baking test is always taken in terms of volume and the following tables take into consideration only the grade, class, originating point, and volume of the different wheats. It would perhaps be of value to have other data on these wheats that would show something of the chemical analyses but as these are not available they cannot be given.

Each class of wheat was ground without blending and represents the true flour from that wheat. The samples were cleaned, scoured, tempered and ground into a straight grade flour on a Wolf Experimental mill. Only one break and one reduction was made and while with this method the yield is rather high still it serves to give a very good comparison of the different samples. Several experiments on the same wheat proved that the comparison was of value and the results quite constant. The break flour was put through an 11xx silk bolting cloth and the patent flour through a 12xx cloth.

TABLE NO. 1, CROP OF 1919

Section	Class	Grade	Samps. Aver.	Ave. Vol.
Southwestern	Hard Winter	1	13	175 cu. in.
Southwestern	Hard Winter	2	122	177 cu. in.
Southwestern	Hard Winter	3	34	180 cu. in.
Southwestern	Hard Winter	4	5	181 cu. in.
Southwestern	Kanred	2	11	171 cu. in.
Illinois	Red Spring	2	7	163 cu. in.
Canadian	Dk. Spg.	1	4	181 cu. in.
Minnesota	Dk. Win.	1	4	184 cu. in.
Minnesota	No. Spg.	1	1	184 cu. in.
Minnesota	No. Spg.	3	11	172 cu. in.
Minnesota	No. Spg.	4	26	169 cu. in.
Minnesota	No. Spg.	5	19	179 cu. in.
Minnesota	Dk. Spg.	2	12	167 cu. in.
Minnesota	Dk. Spg.	3	9	176 cu. in.
Minnesota	Dk. Spg.	4	14	173 cu. in.
Minnesota	Dk. Spg.	5	5	172 cu. in.
North Dakota	No. Spg.	1	3	190 cu. in.
North Dakota	No. Spg.	2	2	175 cu. in.
North Dakota	No. Spg.	3	1	169 cu. in.
North Dakota	Dk. Spg.	1	6	177 cu. in.
North Dakota	Dk. Spg.	2	8	178 cu. in.
North Dakota	Dk. Spg.	3	30	178 cu. in.
North Dakota	Dk. Spg.	4	35	178 cu. in.
North Dakota	Dk. Spg.	5	11	170 cu. in.
South Dakota	No. Spg.	1	3	181 cu. in.
South Dakota	No. Spg.	2	2	185 cu. in.
South Dakota	No. Spg.	5	5	183 cu. in.
South Dakota	Dk. Spg.	2	6	161 cu. in.
South Dakota	Dk. Spg.	3	71	180 cu. in.
South Dakota	Dk. Spg.	4	116	181 cu. in.
South Dakota	Dk. Spg.	5	92	182 cu. in.
Total Samples Averaged			758	

It is to be regretted that the average number of samples for each of the grades is not more uniform. The data is submitted for what value or interest it may be and no conclusions are to be drawn unless as to the grade of wheat of each class, section, and of the entire crop year, that shows the greatest strength.

By ranking the grades according to the average baking value as shown by volume, and expressing each numerically, as volume rank, as compared to total average rank of 100, we get the following values:

No. 1 Wheat=60
No. 2 Wheat=62 6-7
No. 3 Wheat=71 3-7
No. 4 Wheat=65 5-7
No. 5 Wheat=60

By ranking the grades thus shown we see that No. 3 wheat, as taken from the total classes and volumes averaged, shows the best strength for the crop of 1919. Observation of the total baking determination would show that this figure, while perhaps not expressing numerically the true strength, would undoubtedly place No. 3 wheat as the strongest of the crop. This is true of the majority of cases and coincides with the observations of the crop from day to day as the bread was baked. All classes were not ranked, as some had only one grade. The classes ranked were: Southwestern Hard Winter, No. 1, No. 2, No. 3, No. 4; Minnesota Northern Spring, No. 1, No. 3, No. 4 and No. 5; Minnesota Dark Spring, No. 2, No. 3, No. 4 and No. 5; North Dakota Northern Spring, No. 1, No. 2 and No. 3; North Dakota Dark Spring, No. 1, No. 2, No. 3, No. 4 and No. 5; South Dakota Northern Spring, No. 1, No. 2 and No. 5; South Dakota Dark Spring, No. 2, No. 3, No. 4 and No. 5.

TABLE NO. 2, CROP OF 1920.

Section	Class	Grade	Samps. Aver.	Ave. Vol.
Southwestern	Hd. Win.	1	10	167 cu. in.
Southwestern	Hd. Win.	2	17	169 cu. in.
Southwestern	Hd. Win.	3	2	154 cu. in.
Canadian	No. Spg.	1	8	185 cu. in.
Minnnesota	Dk. Win.	1	4	180 cu. in.
Minnesota	Dk. Win.	2	5	176 cu. in.
Minnesota	No. Spg.	3	3	165 cu. in.
Minnesota	No. Spg.	4	20	163 cu. in.
Minnesota	No. Spg.	5	2	169 cu. in.
Minnesota	Dk. Spg.	3	7	184 cu. in.
Minnesota	Dk. Spg.	4	4	175 cu. in.
Minnesota	Dk. Spg.	5	10	181 cu. in.
North Dakota	Dk. Spg.	2	25	187 cu. in.
North Dakota	Dk. Spg.	3	21	187 cu. in.
North Dakota	Dk. Spg.	4	16	187 cu. in.
North Dakota	Dk. Spg.	5	3	184 cu. in.
North Dakota	Hd. Win.	1	28	183 cu. in.
South Dakota	Dk. Spg.	1	4	181 cu. in.
South Dakota	Dk. Spg.	2	2	182 cu. in.
South Dakota	Dk. Spg.	3	11	177 cu. in.
South Dakota	Dk. Spg.	4	24	181 cu. in.
South Dakota	Dk. Spg.	5	25	194 cu. in.
Nebraska	Hd. Win.	1	29	166 cu. in.
Montana	Hd. Win.	1	28	177 cu. in.
Montana	Hd. Win.	2	14	190 cu. in.
Montana	Hd. Win.	3	6	188 cu. in.

By ranking the grades and expressing numerically as in the preceding table we get the following results:

No. 1 Wheat=57 1-7
No. 2 Wheat=60
No. 3 Wheat=60
No. 4 Wheat=57 1-7
No. 5 Wheat=60

These results would show that for the crop of 1920 the wheat of grade No. 2 was the strongest. This fact is also borne out by observations of the daily bakings of the various wheats. Again, as in the former table, all of the classes were not ranked on account of some of them containing only one grade. The classes ranked were: Southwestern Hard Winter No. 1, No. 2 and No. 3; Minnesota Dark Winter, No. 1 and No. 2; Minnesota Northern Spring, No. 3, No. 4 and No. 5; Minnesota Dark Spring, No. 3, No. 4 and No. 5; North Dakota Dark Spring, No. 2, No. 3, No. 4 and No. 5; South Dakota Dark Spring, No. 1, No. 2, No. 3, No. 4 and No. 5; Montana Hard Winter, No. 1, No. 2 and No. 3.

Individual high rank for the crop of 1919 would apparently be North Dakota No. 1 Northern Spring but only three samples of this class and grade have been secured. For the crop of 1920 the individual high rank would be for South Dakota No. 5 Dark Spring, and for this class and grade 25 samples have been averaged that would give a very good average. Where extremes were obtained in the volume or where it was evident that error had been made in the baking experiment the results were not tabulated.

Each loaf would weigh approximately 500 grams, being made from 340 grams of flour. All samples were baked in the usual way and, almost without exception, handled alike as to milling and baking.

Acknowledgement is made to Miss K. F. E. Gleason for conducting the baking experiments and the tabulation of data.

SAMUEL J. LAWELLIN.

NOTES ON SUGAR DETERMINATIONS

Stabilization of Sodium Thiosulphate Solution

Olesen states that, "The most active decomposing influence on the sodium thiosulphate solution seems to be the action of carbon dioxide in the presence of oxygen and sunlight." (Olesen, J. C, Quantititative Analysis, 1908, p. 336.)

An effort has been made to stabalize the thiosulphate solution without the use of the ordinary precautions to exclude carbon dioxide and oxygen from the container. To do this a few grams of solid NaOH were added to the thiosulphate solution when it was prepared. Two lit-

ers of solution were made by dissolving 20 grams pure thiosulphate sale and 10 grams solid NaOH in water, making to two liters and filtering. This solution was then placed in amber colored bottle around which had been placed several thicknesses of gray, light-proof paper. Bottle was tightly stoppered and allowed to stand about two weeks before standardization. This standardization was made May 20, 1920.

Last standardization made was January 14, 1921, and variation on dextrose value of the thiosulphate solution, from first standardization, was within the limits of experimental error. Nearly three-fourths of the two liters have been used, necessitating the opening of the bottle many times. Solution has been standardized many times during this interval and satisfactory checks secured. When solutions were standardized they were checked against pure dextrose solution, potassium permanganate, and iodine solutions.

The addition of the NaOH apparently absorbs carbon dioxide before it can react with the thiosulphate. A comparison between this solution and freshly prepared thiosulphate solution, without NaOH, was made in several regular sugar determinatons, using pure dextrose and cereal extracts, and satisfactory checks secured. The addition of the NaOH does away with all of the precautions in regard to keeping thiosulphate and greatly simplifies the sugar determinations.

Preparation of Starch Solution

To avoid frequent preparation of starch solution for the cuprous chloride-iodide method for reducing sugars it was tried to keep starch solution by carefully sterilizing and then addition of a few cc. of liquid petrolatum. This solution would keep very well for several weeks but bacterial action would in time begin.

The following method of preparation was then employed and found to eliminate bacterial action and prevent changing of the starch solution. With a pestle and mortar, two to four grams of soluble starch are rubbed to a smooth paste with least possible amount of cold distilled water. While constantly stirring with pestle, 200 cc. of boiling distilled water are slowly added and all particles of starch worked up smooth. This solution is then poured into 200 cc. cold distilled water, with constant stirring, and allowed to stand over night.

An Erlenmeyer flask is sterlized by filling part full of water and boiling about twenty minutes. The flask is emptied and, while still hot, the clear supernatant starch solution is decanted into the flask. This is now raised to the boiling point, removed from fire, and immediately about 5 cc. of liquid petrolatum run down side of flask. Flask is lightly stoppered and immersed in cold water. When cool enough to stopper tightly, flask is closed and kept in refrigerator.

Solution made and kept in this manner has remained unchanged until it has been all used, or during a period of about two months. Comparison between this solution and one freshly prepared has shown one to be as good as the other. This method of preparation will eliminate the necessity of making fresh starch solution every few days.

S. J. LAWELLIN.

CHEMICAL CONTROL IN THE BAKERY

Applied chemical endeavor insofar as it is directed toward factory control in the baking industry today, is a minor factor. The leaders among the progressive spirits in the industry have but recently seen the light. The last decade has seen the establishment of the few bakery control laboratories now in operation and the number will increase only as development occurs in the application of chemistry to the art.

In the baking plant there is a wide field for the chemist and there are great possibilities for the manager who avails himself of chemical inspection of supplies and control in manufacture. The bakery chemist must be a well-trained analyst if results are to be achieved, and further he must have a thorough knowledge of the art of bread making.

To illustrate the above statement, let us consider the range covered by an average day's samples. There will be the regular samples such as flour, milk, malt, etc., probably in considerable volume. Then special samples submitted of materials such as salt, sugar, molasses, powdered and frozen eggs, raisins, water, baking powder, yeast foods, shortening material, flavoring extracts and even gasoline and motor oils. To render efficient service the chemist must be equipped to analyze these materials and interpret the result to apply to the manufac-

ture of bread and cake or to meet other factory needs.

The function of each ingredient must be well understood that it may be used with the greatest efficiency. Thus, a thorough knowledge of flour and its characteristics as they apply to baking will require the usual tests as applied in milling laboratories including that very essential test, "the baking test." For the baker it is very important to know the absorption and fermenting period on each flour, these two tests having more weight than they do in the milling laboratory. Other characteristics such as color of crust will be considered as to their bearing on the formula. Witn other constituents it is usually merely a matter of purity, it, of course, being vitally necessary to know the effect of impurities or low qualities on the process of fermentation and baking. Variation in quality is disastrous to the production of a uniform product in the first place and secondly it has the usual bearing on manufacturing cost. Such products as malt, molasses, compound, milk and baking powder are subject to considerable variation at times. It is necessary to give special attention to the diastatic value of malts; the sugar contents of syrups; the acidity and melting point of shortening material; the sucrose, water and fat of milk; the available gas content of baking powder; the vitality of yeast and the potent ingredients in specialty compounds.

We will not dwell on the consideration of the functions of the materials mentioned as a considerable volume would be necessary to even consider that phase, but let us give some attention to the more general application of the laboratory of the factory. The chemist can only serve his employer well when he can assist in solving the problems of the manager and superintendent as they occur in the plant. Problems of fermentation are, of course, the most important. Each ingredient in the batch has a bearing on the rate of fermentation and type of product; methods of handling; type of machinery, condition and type of ovens as well as seasons of the year and weather conditions all have direct bearing on the process. For instance, let us consider the one factor, "Texture." It will be influenced by style of dough, that it, straight or sponge; by the degree of development attained before dividing; the characteristics of the blend of flour used and by the quantity of such ingredients as milk, sugar, malt, etc., these and other factors. We can go thru the whole list of properties of bread and find many factors that effect each one. For such a simple thing as "color of crust" we must consider in making a formula such things as sugar added as such; sugar in malt used; sugar in milk used (speaking of sweetened condensed milk; grease in and on the dough; steam in proofing and temperature of the oven. Some factors vary with more or less regularity such as the temperature of the ovens and these must be met in such a way as to produce the best results.

It is the duty of the chemist in charge to carefully consider every ingredient of the dough, to correlate the analytical data and so choose materials and regulate proportions that the best possible formula, for the type and quality of bread desired may be available. He it is who must carry the improvement beyond the point where the craft has done all it can. It devolves upon him to see the finer relations and distinctions in ingredients and their constituents and so balance them as to get the very best possible results. A thorough chemical knowledge of the constituents of each material in a dough batch is essential for intelligently formulating a recipe.

The production of a good loaf of bread involves many factors and these factors are not physical only nor alone chemical, but are both physical and chemical, and, if the distinction may be allowed, fermentive also. It has been pointed out that physical factors, such as method of handling, type of machines, oven conditions, etc., have a profound influence on the results. Let us consider the factors that may be called chemical and fermentive. As is always the case in compounding materials, the chemical similarity of the component parts as well as the incompatibility of the other components requires careful consideration. In our case the problem is complicated by a second relation, that of yeast to each of the constituents of the mixture.

Thus the case presents some such problem is this:

Given a flour of normal strength, color and absorption to produce a quality loaf of bread, that is, one having good volume, crust color, texture, flavor, etc. The formula will require sufficient yeast to carry the fermentation thru in normal time.

Sugar is supplied in quantity sufficient to sustain vigorous fermentation and enough more to give color to the crust when ovens are normal. Flashy ovens will require a reduction in the sugar and cool ovens an increase.

Salt is added for flavor, therefore the amount is limited either way, but it also has a retarding action on fermentation so a balance must be maintained and any variation overcome by some other force. Thus:

Malt acts opposite to salt in that it accelerates the rate of fermentation thru its diastatic action, but that is not all; it contains easily fermentable sugars also. It is then necessary to adjust the granulated sugar content to offset the malt addition. The malt contains dextrin which tends to color the crust and soluble proteins that aid fermentation so it is evident that the time of fermentation may be affected.

Shortening is added for its effect on the eating qualities of the loaf as well as the keeping quality. It affects the color of the crust and crumb and also the texture and if it is in the nature of an oil it will modify the amount of water necessary for a definite consistency of dough.

The amount of water added is responsible for the degree of slackness obtained and that will necessarily be governed by type of bread desired and facilities for handling. Furthermore, if it has considerable quantities of mineral matter in it, it will affect the rate of fermentation either by hastening or retarding, that depending upon the character of the dissolved solids.

If then, it is desired to add sweetened condensed milk for its effect in the finished loaf, we must consider that ingredient from the standpoint of its composition. Being approximately 40 per cent cane sugar we must again alter our granulated sugar content of the mixture. Having 30 per cent of water it replaces a definite amount of water added as such. If it contains butterfat the shortening ratio of the dough must be readjusted. Finally, its effect on color of crust and texture of crumb must be corrected for.

It is now evident that there are many relations to be considered in assembling the ingredients of a dough batch. At that, we have considered only the simplest ones and not mentioned yeast foods, substitutes and improvers ,nor have we considered the factors which also have a bearing on the formula. The laboratory can aid in arriving at the best formula to be used in producing a preconceived type of bread. Guesswork and trial can be reduced to a minimum and faults and poor quality corrected speedily and intelligently. The laboratory is a means of discerning faults both in manufacturing processes and materials used. The chemist brings to the aid of the superintendent a fund of knowledge that assists him in solving problems of fermentation, developing new methods of operation and improving the old. Plant operations are less liable to irregularity and confidence on the part of the baker results.

It is well to emphasize the point that a batch of poor bread costs much in trade lost and the only way to avoid that is to know definitely all the conditions affecting the manufacture so that only a good product will be turned out. The value of chemical control arises from the benefit derived thru avoiding poor materials, faulty operation, mediocre product, etc. In recapitulation, I would say that chemical control

Insures raw materials of constant quality,

Assists in developing suitable formulas,

Provides a means of tracing faults to their source,

Provides a fund of exact knowledge, otherwise unavailable, for application to manufacturing problems.

Insures uniformity of finished product.

Stimulates confidence in the hearts of the craftsmen.

The value of chemical control is thus briefly outlined. The field is new and the possibilities for further development are almost limitless. History repeats its self and it is safe to say that the baking industry, like so many other industries in the past, will, in the not distant future, accept chemical control as "standard practice."

R. W. MITCHELL.
President A. A. C. C.

ABSTRACT

Bacteriology as Applied to Baking

By Dr. Cleveland C. MacLane
Bakers Weekly, Vol. 28, No. 10,
12,—4,—'20.

In this article a study of yeast and fermentation is made. A brief historical resume is given followed by a short discussion of the general nature and the individuality of the yeast cell.

A classification of the Saccharomycetes is given followed by outlines for the physical and microscopical examination of a bakers yeast. The remarks and outlines for this examination follow:

The cultivated yeast, Saccharomycetes Cerevisiae, is divided into two separate classes, a top and a bottom fermenting yearst. Each species of yeast is made up of many varieties, which will be found to differ from each other in one or all of the following points:

1. The energy of growth.
2. The size and shape of cells.
3. The power to resist infection.
4. The power of producing greater or less fermentation.
5. The rapidity of fermenting.
6. The flavor given to the bread in some cases.
7. Those which do not ferment sugars for the production of alcohol and carbonic acid gas.

In the physical examination of yeast it might be well to follow the following outline and detect goodness or badness with our endowed five senses and we will consider the following points ,those that we see, taste, smell or feel.

Good Yeast:

I. Smell:
Aromatic.

II. Taste:
Slightly bitter.

III. Consistency.
1. Medium, uniform throughout. Bubbles of CO_2. Cakes heavy and firm to touch. Will break in distinct pieces. Can crumble

IV. Color:
Light yellow to white.

Disturbed Yeast.

I. Smell:
1. Acid odor.
A. Micoderma.
B. Bacteria.
2. Putrid odor.
A. Self fermentat.
B. Rotten.
3. Rancid odor.
A. Bacteria.

II. Taste.
1. Acid, sour.
Bacteria.
2. Rancid, old butter.
Bacteria.

III. Consistency:
1. Thin, watery.
(a) Self fermentation.
(b) Rotten fermentation
(c) Bacteria.
(d) Slime moulds.
(e) Dead culture.

IV. Color:
1. Dark yellow. Albuminous matter present has been dried.
Starting auto-fermentation. Compresses with an admixture of starch.
2. Brown
Suspicious, as it denotes self-fermentat or rotten fermentation.
Bacteria.
3. Green, blue, black.
Pencillium.
Moulds.
Aspergillus.
Mucor.

This outline, handled quickly and well gives us at once an insight into starting trouble. It is impossible to condemn a yeast if one or more of the above defects are present and say with absolute certainty that we are dealing with an inferior yeast. Mould contamination speaks for itself and condemns. No yeast should be favored or condemned by a physical examination alone, but a microscopical examination should follow, under the following form, to clinch our examination:

I. APPEARANCE OF THE INDIVIDUAL CELL.

Good Yeast.	Disturbed Yeast.
1. Consistency of Protoplasm.	
A. Homogenous or liquid. B. Few granules. C. Slight vacuolation.	A. Markedly granular. B. Excessive vacuolation.
2. Appearance of Cell Wall.	
A. Fine circular or oval line.	A. Thick. Retarding influences.
B. Regular in outline.	B. Irregular outline. Interferred with, may be boiled, crushed or dried.
C. Single wall.	C. Double wall. Protoplasm has shrunk, generall a dead cell. D. Ruptured. Dead cell. E. Stain very heavy with a dilute solution of methylene blue, are dead or dying.
3. Shaps of Cells.	
A. Round. B. Oval.	A. Irregular.
4. Size of Cells.	
A. 6 to 9 microns. B. Medium.	A. Very small. B. Very large. Mixed yeast. Contamination. Wild yeast.
5. Percentage of Dead Cells.	
None or less than one per cent. Few stain faintly with methylene blue.	Many or all, or over 20 per cent, coagulated protoplasm. Double wall. Stain deeply with methylene blue.
6. Percentage of Weakened Cells.	
5 per cent. No staining.	Over 40 per cent. Stain with meth. bue. Double or wavy cell wall.
7. Almuminous Matter.	
Small amounts. Occurs as round, scintilating, moving objects (Brownian movement.)	Great amounts. May have to be dissolved out to see remaining yeast cells.
8. Starch.	
Little or none.	Much if added and no breaking down by enzymes. Will have typical structure — five-sided, round or sharp corners, concentric rings in potato. Hilus generally found in potato, corn, rice, etc.
9. Bacteria.	
None if pure culture.	Present or many, depends upon amount of interference. Look for shapes: rod, ball, chains, masses, pair, packages, spores.

10. Moulds.

None.	Present. Mycelial filaments. Fruit hyphae. Aerial hyphae. Spores. Sporangium. Collumella. Basidia.

11. Wild Yeast.

None.	11. Wild yeast: Different strains, varying in size, change of fermentation.

With our examination focused by means of this scheme of observation we can readily determine the defects of yeast and answer the question, "What condition has been brought about that causes a given good yeast to change, so as to give only fair or poor results?"

W. L. RAINEY.

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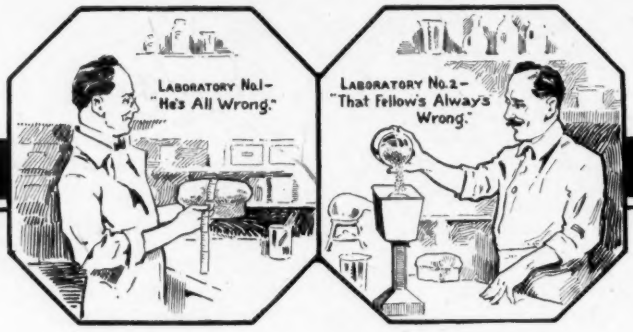

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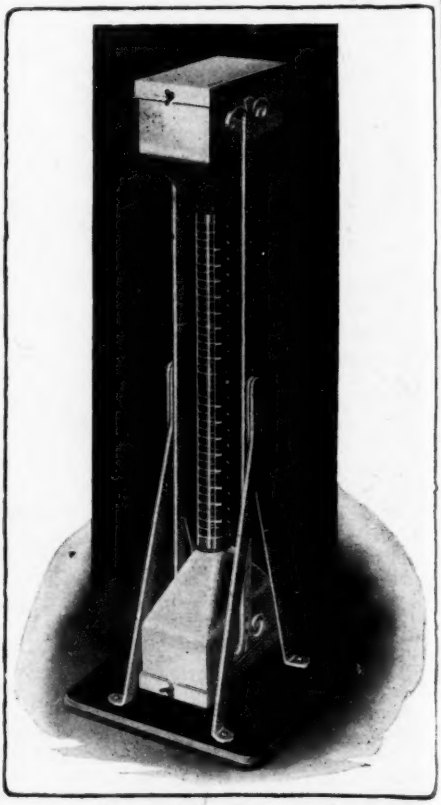

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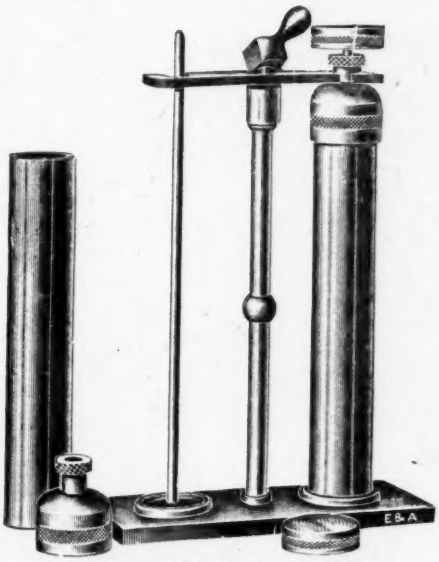

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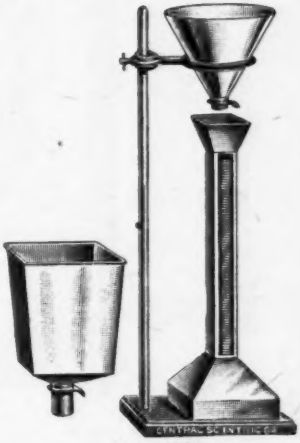

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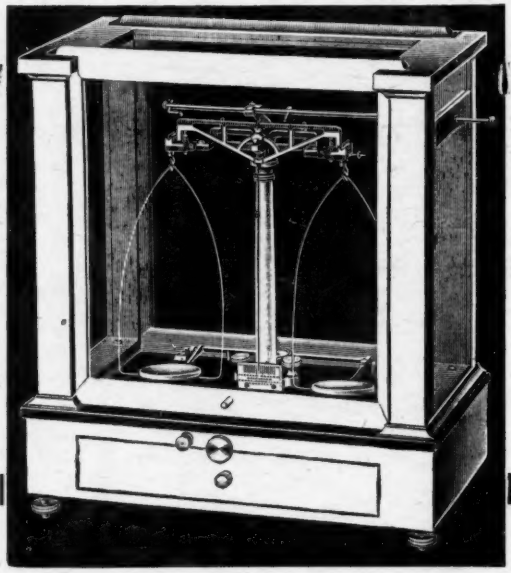

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